

# **Scheme & Syllabus of**

## **Pre-Ph.D. Course Work -Biotechnology**



**IK Gujral Punjab Technical  
University**

# I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Estd. Under Punjab Technical University Act, 1996  
(Punjab Act No. 1 of 1997)

Ref. No. : IKGPTU/Reg/N/

Dated :

## NOTIFICATION

Sub: **Regarding Pre-Ph.D Course work.**

This is for information of all concerned that Pre-Ph.D course work from 2016-17 will be conducted in the IKGPTU main campus Kapurthala in regular mode. The PhD course work will consists of minimum 15 credits. The structure of the course work is as under.


Sr. No.	Nature of course	Name of course	Credits	Remarks
1.	Core	1. Research Methodology	4	The syllabus of RM should be formulated faculty wise such as Engineering, Science, Management/ Humanities and Life sciences
		2. Subject related theory paper	4	Discipline specific related to advancements in theoretical methods for research
		3. Presentation	3	Discipline specific
2.	Interdisciplinary	4. Elective	4	From list of subjects from allied fields
<b>Total Minimum credits</b>			<b>15</b>	

-Sd-  
Registrar

Endorsement No: IKGPTU/REG/N/ 4244-4251

Dated: 22-08-2016

1. Secretary to Vice Chancellor: For kind information of Vice Chancellor
2. Dean (P&D)
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Registrar

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<b>Research Methodology</b>	The already approved syllabus of RM for PhD course work
<b>Core Subjects</b>	<b>Options</b>
	Biochemical and Separation Techniques
	Bioprocess Technology
	Recombinant Biotechnology
<b>Interdisciplinary Subjects</b>	Plant Tissue Culture
	Modern Pharmaceutical Analytical Techniques
	Intellectual Property Rights Pharmacological and Toxicological Screening Methods

## CORE SUBJECTS

### **Option-I**

#### **BIOCHEMICAL AND SEPARATION TECHNIQUES**

##### **1 Chromatography**

1.1 Introduction, Principles, Types- paper, two dimensional, HPLC, Ion exchange chromatography, Uses, Advantages and Limitations

##### **2 Spectroscopy**

2.1 UV/Visible

2.2 Spectrophotofluorimeter

2.3 Scope, basic principle and uses in biotechnology of different types of spectrometry (NMR, Magnetic resonance spectroscopy)

##### **3 Radioisotopy**

3.1 Use of radioisotope

3.2 Detection and measurement of radioactivity

3.3 Specific activity

3.4 Applications in biological system

3.5 Autoradiography

##### **4 Microscopy**

4.1 Brief introduction

4.2 Types of microscopes and role in microbiology

4.3 Structure and function of microscopes (compound microscope, dissecting microscope, phase contrast microscope, scanning electron microscopy)

##### **5 Filtration**

5.1 Theory and application

##### **6 Centrifugation**

6.1 Theory and application

##### **7 Electrophoresis**

7.1 Different methods for proteins and nucleic acids

##### **8 Molecular Diagnostic Techniques**

8.1 PCR

8.2 Southern, Northern, Western Blotting

8.3 Microarray

#### **Suggested Reading/Reference Books:**

- Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker. Cambridge University Press.

- Laboratory Techniques in Biochemistry and Molecular Biology. P.C. van der Vliet and S. Pillai. Elsevier

## **Option II**

### **BIOPROCESS TECHNOLOGY**

#### **1 Microbial Growth Kinetics**

- 1.1 Batch Culture
- 1.2 Continuous culture
- 1.3 Fed-batch culture
- 1.4 Biomass productivity
- 1.5 Metabolite productivity
- 1.6 Kinetics of microbial growth

#### **2 Enzymes**

- 2.1 Classification
- 2.2 Uses
- 2.3 Methods for immobilization

#### **3 Fermentation**

- 3.1 Raw materials used as media for industrial fermentations
- 3.2 Development of inocula for industrial fermentations
- 3.3 Isolation and preservation of industrially important microorganisms

#### **4 Design of a Fermenter**

- 4.1 Aseptic operation and containment
- 4.2 Construction materials
- 4.3 Temperature control
- 4.4 Aeration and agitation
- 4.5 Sterilization of the fermenter
- 4.6 Air supply and exhaust gas from a fermenter

#### **5 Recovery and Purification of Fermentation Products**

- 5.1 Centrifugation
- 5.2 Cell Disruption
- 5.3 Chromatography
- 5.4 Ultra filtration
- 5.5 Drying

#### **Suggested Reading/Reference Books**

- Principles of fermentation technology by Stanbury, Whitaker & Hall.
- Bioprocess Engineering by Shuler M. L. and Kargi F.
- Microbiology by Pelczar, Chan & Krieg.
- Microbiology by Prescott, Harley & Klein.
- Modern Industrial Microbiology & Biotechnology by Nduka Okafor.

## **Option III**

### **RECOMBINANT BIOTECHNOLOGY**

#### **1 Tools of Genetic Engineering**

- 1.1 Cloning vehicles
- 1.2 Modifying enzymes
- 1.3 DNA ligase
- 1.4 DNA polymerase
- 1.5 Polynucleotide kinase
- 1.6 T4 DNA ligase
- 1.7 Nick translation system
- 1.8 Terminal deoxynucleotidyl transferase
- 1.9 Reverse transcriptase
- 1.10 Restriction endonucleases Type I & II. etc.

#### **2 Cloning Vectors**

- 2.1 Plasmids
- 2.2 Lambda phage
- 2.3 Phagemids
- 2.4 Cosmids
- 2.5 Artificial chromosomes
- 2.6 Yeast vectors
- 2.7 Shuttle vectors
- 2.8 Virus based vectors

#### **3 Methods of Gene Transfer**

- 3.1 Transformation
- 3.2 Transduction
- 3.3 Particle gun
- 3.4 Electroporation
- 3.5 Liposome mediated
- 3.6 Microinjection
- 3.7 *Agrobacterium* mediated gene transfer

#### **4 Preparation and Application of Molecular Probes**

- 4.1 DNA probes
- 4.2 RNA probes
- 4.3 Radioactive labelling
- 4.4 Non radioactive labelling
- 4.5 Use of molecular probes
- 4.6 DNA fingerprinting

#### **5 Analysis and Expression of Cloned Gene In Host Cells**

- 5.1 Expression vectors
- 5.2 Restriction enzyme analysis

- 5.3 Southern blotting
- 5.4 Northern blotting
- 5.5 Western blotting
- 5.6 *In-situ* hybridization
- 5.7 Colony and plaque hybridization
- 5.8 Factors affecting expression of cloned genes
- 5.9 Reporter genes
- 5.10 Fusion proteins

## **6 Gene Libraries**

- 6.1 cDNA synthesis
- 6.2 Genomic DNA libraries
- 6.3 Amplification of gene libraries
- 6.4 Identifying the products of cDNA clones

## **7 Isolation, Sequencing and Synthesis of Gene**

- 7.1 Different methods of gene isolation
- 7.2 Techniques of DNA sequencing
- 7.3 Artificial DNA synthesis

## **8 Applications of r-DNA Technology**

- 8.1 Gene cloning in medicine (Insulin, Blood clotting factor VIII)
- 8.2 High level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells)
- 8.3 Limitation and advantages and novel technologies generation of transgenic animals
- 8.4 Applications of PCR (DNA finger printing)

## **9 Gene Therapy**

- 9.1 *Ex vivo* & *In vivo* gene therapy
- 9.2 Case study of ADA as an example
- 9.3 Gene therapy prospect and future
- 9.4 DNA vaccine
- 9.5 Transgenic plants
- 9.6 Advantages and limitations of gene therapy
- 9.7 Antisense and ribozyme technology
- 9.8 Micro RNA Technology
- 9.9 Human genome project and its application
- 9.10 Current production of rDNA products
- 9.11 Bio-safety measures and regulations for rDNA work

## **Suggested Reading/Reference Books**

- Principles of Gene Manipulation by R.W.Old and S.B.Primrose Sixth Edition Blackwell Scientific Publication (2001)
- Genes VIII by B.Lewin

- From Genes to Clones by E.L.Winnecker
- Gene Cloning by T.A.Brown
- Glick B., Pasternak J. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Ed. ASM Press

## **Option IV**

### **PLANT TISSUE CULTURE**

#### **1 Introduction to Cell and Tissue Culture**

- 1.1 Conventional plant breeding
- 1.2 Tissue culture as technique to produce novel plants and hybrids
- 1.3 Tissue culture media (composition and preparation)
- 1.4 Initiation and maintenance of callus and suspension cultures
- 1.5 Single cell clones

#### **2 Organogenesis: Somatic embryogenesis**

- 2.1 Transfer and establishment of whole plants in soil
- 2.2 Shoot tip culture
- 2.3 Rapid clonal propagation
- 2.4 Embryo culture and embryo rescue

#### **3 Protoplast**

- 3.1 Isolation
- 3.2 Culture and fusion
- 3.3 Selection of hybrid cell and regeneration of hybrid plants
- 3.4 Symmetric and asymmetric hybrids, cybrids
- 3.5 Cryopreservation
- 3.6 Slow growth and DNA banking for germplasm conservation

#### **4 Plant Transformation Technology**

- 4.1 Basis of tumor formation
- 4.2 Hairy root
- 4.3 Features of TI and RI plasmids
- 4.4 Mechanism of DNA transfer
- 4.5 Role of virulence genes
- 4.6 Use of TI and RI as vectors
- 4.7 Binary vectors
- 4.8 Genetic markers
- 4.9 Use of reporter genes
- 4.10 Reporter gene with intron
- 4.11 Methods of nuclear transformation
- 4.12 Viral vectors and their application
- 4.13 Multiple gene transfer
- 4.14 Vectorless or direct DNA transfer (particle bombardment, electroporation, microinjection)
- 4.15 Transformation of monocots
- 4.16 Transgene stability and gene silencing

#### **5 Application of Plant Transformation for Productivity and Performance**

- 5.1 Herbicide resistance (phosphinothricin, glyphosphate, sulfonyl urea, atrazine)
- 5.2 Insect resistance (Bt genes, non-Bt like protease inhibitors, alpha amylase inhibitor)
- 5.3 Virus resistance (coat protein mediated, nucleocapsid gene)
- 5.4 Disease resistance (chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins)
- 5.5 Nematode resistance
- 5.6 Abiotic stress

- 5.7 Post harvest losses
- 5.8 Use of ACC synthase (polygalactouranase, ACC oxidase)
- 5.9 Male sterile lines
- 5.10 Bar and barnase systems
- 5.11 Carbohydrate composition and storage
- 5.12 ADP glucose pyrophosphatase
- 5.13 Biosafety and ethical issues associated with transgenic plants

## **6 Chloroplast Transformation**

- 6.1 Advantages
- 6.2 Vectors
- 6.3 Success with tobacco and potato

## **7 Metabolic Engineering and Industrial Products**

- 7.1 Plant secondary metabolites
- 7.2 Role of bioreactors for scaling up
- 7.3 Biotransformation
- 7.4 Biodegradable plastics, polyhydroxybutyrate

## **8 Molecular Pharming in Plants**

- 8.1 Production of therapeutic proteins
- 8.2 Edible vaccines antibodies
- 8.3 Purification strategies

## **Suggested Reading/Reference Books**

- Biotechnology in Crop Improvement by H.S Chawla
- Plant Biotechnology BY J.Hammond , P.McGravey and V.Yusibov
- Elements of Biotechnology by P.K Gupta
- Practical application of Plant Molecular Biology by R.J Henry

## INTERDISCIPLINARY SUBJECTS

### **Option-I**

#### **MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES**

##### **1. UV-Visible spectroscopy**

- 1.1 Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy
- 1.2 Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy

##### **2. IR spectroscopy**

- 2.1 Theory, Modes of Molecular vibrations, Sample handling
- 2.2 Instrumentation of Dispersive and Fourier - Transform IR Spectrometer
- 2.3 Factors affecting vibrational frequencies and Applications of IR spectroscopy

##### **3. Spectrofluorimetry**

- 3.1 Theory of Fluorescence, Factors affecting fluorescence, Quenchers
- 3.2 Instrumentation and Applications of fluorescence spectrophotometer

##### **4. NMR spectroscopy**

- 4.1 Quantum numbers and their role in NMR
- 4.2 Principle, Instrumentation, Solvent requirement in NMR
- 4.3 Relaxation process
- 4.4 NMR signals in various compounds
- 4.5 Chemical shift, Factors influencing chemical shift
- 4.6 Spin-Spin coupling, Coupling constant
- 4.7 Nuclear magnetic double resonance
- 4.8 Brief outline of principles of FT-NMR and <sup>13</sup>C NMR
- 4.9 Applications of NMR spectroscopy

##### **5. Mass Spectroscopy**

- 5.1 Principle, Theory, Instrumentation of Mass Spectroscopy
- 5.2 Different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers of Quadrupole
- 5.3 Time of Flight, Mass fragmentation and its rules
- 5.4 Meta stable ions, Isotopic peaks
- 5.5 Applications of Mass spectroscopy

##### **6. Chromatography**

Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of the following: a) Paper chromatography b) Thin Layer chromatography c) Ion exchange chromatography d) Column chromatography e) Gas chromatography f) High Performance Liquid chromatography g) Affinity chromatography

##### **7. X ray Crystallography**

- 7.1 Production of X rays

- 7.2 Different X ray methods
- 7.3 Bragg's law
- 7.4 Rotating crystal technique
- 7.5 X ray powder technique
- 7.6 Types of crystals
- 7.7 Applications of X-ray diffraction

### **Suggested Readings**

- Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
- Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
- Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
- Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 1997.
- Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
- Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.
- Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series.

## **Option-II**

### **INTELLECTUAL PROPERTY RIGHTS**

1. Definition, need for patenting, Types of Patents, Conditions to be satisfied by an invention to be patentable, Introduction to patent search. Parts of patents. Filing of patents. The essential elements of patent; Guidelines for preparation of laboratory note book, Non-obviousness in Patent.
2. Role of GATT, TRIPS, and WIPO
3. Brief introduction to Trademark protection and WHO Patents. IPR's and its types, Major bodies regulating Indian Pharmaceutical sector
4. Brief introduction to CDSCO. WHO, USFDA, EMEA, TGA, MHRA, MCC, ANVISA
5. Regulatory requirements for contract research organization. Regulations for Biosimilar

### **Suggested Readings**

- Pharmaceutical Process Validation: By Fra R. Berry and Robert A. Nash, Vol 57, 2<sup>nd</sup> Edition
- Applied Production and Operation Management By Evans, Anderson and Williams
- GMP for pharmaceuticals Material Management by K.K. Ahuja Published by CBS publishers
- ISO 9000-Norms and explanations
- GMP for pharmaceuticals- Willing S.H. Marcel and Dekker

## **Option-III**

### **PHARMACOLOGICAL AND TOXICOLOGICAL SCREENING METHODS**

#### **1. Laboratory Animals**

- 1.1 Common lab animals: Description, handling and applications of different species and strains of animals
- 1.2 Transgenic animals: Production, maintenance and applications
- 1.3 Anaesthesia and euthanasia of experimental animals
- 1.4 Maintenance and breeding of laboratory animals
- 1.5 CPCSEA guidelines to conduct experiments on animals
- 1.6 Good laboratory practice

#### **2. Preclinical screening of new substances for the pharmacological activity**

- 2.1 General principles of preclinical screening
- 2.2 CNS Pharmacology: behavioral and muscle coordination, CNS stimulants and depressants, anxiolytics, anti-psychotics, anti epileptics and nootropics. Drugs for neurodegenerative diseases like Parkinsonism, Alzheimers and multiple sclerosis. Drugs acting on Autonomic Nervous System
- 2.3 Respiratory Pharmacology: anti-asthmatics, drugs for COPD and anti allergies
- 2.4 Reproductive Pharmacology: Aphrodisiacs and antifertility agents
- 2.5 Analgesics, antiinflammatory and antipyretic agents
- 2.6 Gastrointestinal drugs: anti ulcer, anti -emetic, anti-diarrheal and laxatives
- 2.7 Cardiovascular Pharmacology: antihypertensives, antiarrhythmics, antianginal, antiatherosclerotic agents and diuretics. Drugs for metabolic disorders like anti-diabetic, antihyperlipidemic, and agents.
- 2.8 Anti cancer agents
- 2.9 Immunosuppressants and immunomodulators

#### **3. Limitations of Animal Experimentation and Alternate animal Experiments**

#### **4. Extrapolation of in vitro Data to Preclinical and Preclinical to Humans**

#### **5. Regulatory guidelines for conducting toxicity studies**

- 5.1 OECD
- 5.2 ICH
- 5.3 EPA
- 5.4 Schedule Y
- 5.5 OECD principles of Good laboratory practice (GLP)

#### **Suggested Readings**

- Biological standardization by J.H. Burn D.J. Finney and I.G. Goodwin
- Screening methods in Pharmacology by Robert Turner. A
- Evaluation of drugs activities by Laurence and Bachrach
- Methods in Pharmacology by Arnold Schwartz
- Fundamentals of experimental Pharmacology by M.N.Ghosh
- Pharmacological experiment on intact preparations by Churchill Livingstone

- Drug discovery and Evaluation by Vogel H.G.
- Hand book on GLP, Quality practices for regulated non-clinical research and development (<http://www.who.int/tdr/publications/documents/glp-handbook.pdf>)
- Schedule Y Guideline: drugs and cosmetics (second amendment) rules, 2005, ministry of health and family welfare (department of health) New Delhi
- Drugs from discovery to approval by Rick NG.
- Animal Models in Toxicology, 3rd Edition, Lower and Bryan
- OECD test guidelines.
- Principles of toxicology by Karen E. Stine, Thomas M. Brown.
- Guidance for Industry M3(R2) Nonclinical Safety Studies for the Conduct of Human Clinical Trials and Marketing Authorization for Pharmaceuticals (<http://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm073246.pdf>)